SPACE DEBRIS OBSERVATION POSSIBILITIES BY SBG CAMERA

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Abstract

An optical surveillance system of passive satellites and space debris should have different type of sensors to achieve the detection, tracking and identification tasks. In Europe there are several optical systems capable to detect or track space debris. This number of sensors can increase by some developments in detection technique for the existing photographic cameras planned and used for satellite observations. The different types of sensors are not necessarily be located at the same station if the stations can be integrated into a network and the near real time operation can be achieved. In such a network could be integrated the so called SBG camera, constructed by Carl Zeiss Jena. This camera has a Schmidt optical system with wide field of view and so it could be a useful element of a network producing valuable data in the detection process, either in staring or scanning mode.

Introduction

The appearance of the artificial space objects was followed by the space debris. The space is a special field of human activity, where the byproduct or rubbish produced by an activity cannot be simply eliminated or collected. Although many studies and conference papers are dealing with the question how to decrease the space debris number, according to the real situation - this number is steadily increasing. Partly because of new rocket launches, partly by the collision of existing debris. During the planning and realization of a space mission this fact should be taken into account. This can be efficiently done if one can have sufficient information on the positions or orbits of space debris that are dangerous for that mission.

The task to maintain a good information bank on space debris can be solved by their continuous observations on global bases in international cooperation. The efficiency of an individual observing station could reach high level only if it belongs to a network. And this efficiency can be increased if the stations share their tasks. This is possible due to the fact, that for detection, tracking and orbit determination different type of stations are appropriates which could differ not only in technical parameters, but strongly in prices. In a task-sharing network the number of stations making detection task by a cost effective optical sensor could increase for the better sky covering and better efficiency in searching for new space debris on lower orbits.

1.Optical observations of space debris

The main tasks of an optical tracking network are:

- detection,
- tracking,
- identification and
- data bank update.

The detection and tracking tasks can be separated if the stations are cooperating.

For detection an optical telescope (optical system + detector) with wide field of view is appropriate. The search for new objects can be made either in staring or scanning mode. The requirements for the mount system of such telescopes are not too hard; low slewing rate and low acceleration are sufficient, so the

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astronomical telescopes or photographic cameras planned and used for satellite observations could be used for this purpose.

For tracking an optical telescope with narrow field of view is appropriate. The mount system of this telescope must be capable for high slewing rate (20 °/sec) and high acceleration (10 °/sec^2). Thus only the telescopes planned special for this purpose can be used.

The sky coverage must be also taken into consideration. Even if using wide field of view telescopes, the angular coverage along a LEO orbit is minified by about one order of magnitude. Due to this minification for good sky coverage multiple telescopes are needed. Efficient detection can be taken only by a network of stations cooperating in real time via communication lines. In this case one tracking type station can serve for several detecting stations. Thus in a network the number of detecting stations can be much higher than the number of tracking stations. In the age of communication the tracking and detecting stations are not necessarily be located at the same place. In Europe there are several optical systems capable to detect or track space debris. These individual stations could be integrated into a network - e.g. , Netwoek for European Space Debris Observation - NESDO (the authors proposal) - and thus the real time or near real time operation can be achieved.

2. Application of photographic cameras

The need to search large areas of sky requires telescopes with wide field of view. Telescopes based on Schmidt optical system could fulfill this requirement. Two of the satellite cameras have Schmidt reflectors : the Baker-Nunn Camera and the so called SBG Camere (Satelliten Beobachtungs Gerat). The Baker -Nunn Camera has a focal length of 50 cm with a relative aperture of 1:1. The field of view is 5°x30°, and only film is used because the focal surface is curved.

The SBG Camera, developed by Carl Zeiss Jena, has a four axis mount system and can consecutively track either the stars or the satellites. The mount supports a Schmidt reflector. The main parameters of Schmidt telescope are:

- focal length	788.1 mm
- free diameter of corrector plate	425 mm
- relative aperture	1 : 1.84
- free diameter of main mirror	500 mm
- free diameter of evener lense	150 mm
- field of view	11.3°
- photoplate format	90 mm x 120 mm

The optical system corresponds to a basic Schmidt camera, but it is possible to modify it toa Cassegrain - Schmidt system. The main mirror has a bore and if we place a spherical mirror between the main mirror and the focal plane, it will result a fast focus behind the main mirror.

The focal surface is flat, and thus photographic plates used. An automatic plate changing device mounted in the focal plane contains the photographic plates. This feature is an advantage because instead of the automatic plate-changing device a CCD camera could easily mount. The Schmidt optical system of SBG can see on Fig.1. The mount system supports only the low speed satellite tracking because the maximal slewing rate is 1°/sec. It can use as an astronomical telescope as it also has high accuracy sidereal tracking capability.

These satellite cameras were out of use in the last 10 years, inspite that they could use for some special astronomical and geophysical applications (comet and asteroid, geosynchronous satellite observations). Recently some of them were reused for astrometrie (4 Baker-Nunn camera have been sold for astronomers, who will use them for comet observations after upgrading the detection system.

A BMK camera has been also equipped with CCD detector and used for geosynchronous satellite observations at Graz Lustbuhel Observatory.) Similar way would be imaginable for the further use of the SBG cameras. If the developements serve not only the astronomical but even the space debris observations the two type of observations could be carried out in good combination, mainly if LEO orbits are observed.

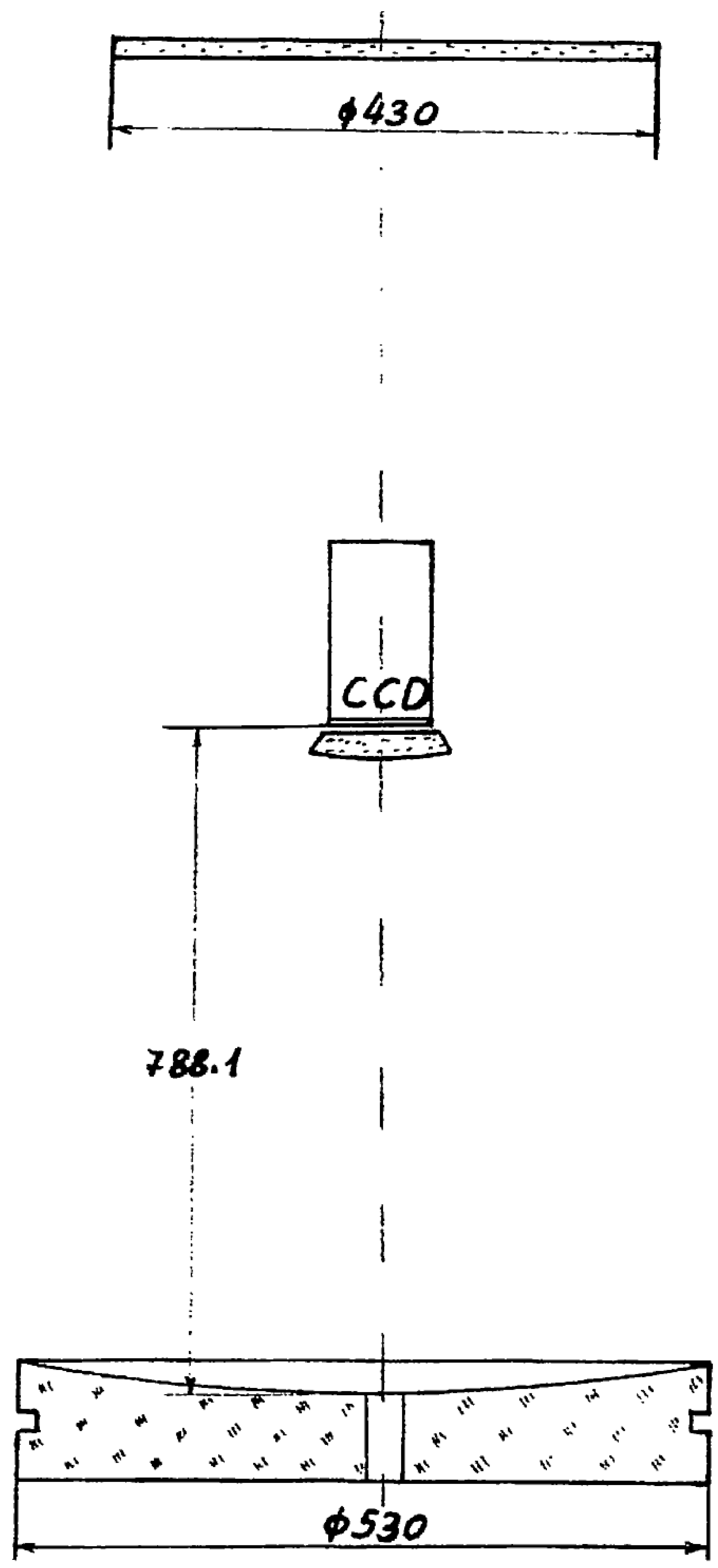

Fig. 1. The Schmidt optical system of SBG camera

We are also planning such exploitation of our SBG camera. After the developments - mainly in the detection system - we are ready to join to a European network and take part in coordinated observations of space debris. We have also intentions to use our camera for astronomical observations in the frame of bilateral cooperation between Penc station and Slovak Astronomical Observatory, located at Skalnate Pleso in Tatra Mountain.

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